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ABSTRACT

Reading comprehension skills can be taught effectively across the curriculum leading to enhanced critical thinking and reading skills, as well as improved performance in content areas. Skilled readers plan their approach to the task at hand, monitor their learning as they read, apply strategies to foster learning, evaluate, and if necessary, revise their approach to learning from texts. The best approach to creating independent readers is to guide them in acquiring strategies for attacking texts on their own. Instructional procedures that introduce strategies as they are needed in the context of actually understanding texts, where the strategies are demonstrated over time, and where the student is fully informed of the purpose of the strategy, produce long-lasting, significant improvements in reading comprehension scores. A description is presented of one such instructional program in which the techniques of expert scaffolding of materials and reciprocal teaching through dialogue are used. The dialogue includes spontaneous discussion and argument and four main comprehension-fostering activities: summarizing, questioning, clarifying, and predicating. Implications for curriculum reform in reading comprehension are discussed. A six-page list of references concludes the document. (JD)

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Reading Education Report No. 58

TEACHING STUDENTS TO THINK AS THEY READ: IMPLICATIONS FOR CURRICULUM REFORM

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Abstract

Higher order thinking skills and effective reading strategies can be taught, and should feature prominently in curriculum. In this paper, advances in instructional research are reviewed briefly and implications for curriculum design discussed. Strategies of critical reading and methods of teaching them to less able students are described. Essential features of successful instruction include not only informing students of the purpose of strategies and their appropriate occasions of use, but also providing settings where students can monitor and control their own learning. Instructional procedures that introduce strategies as they are needed, in the context of actually understanding texts, where the strategies are modelled over time, and where the student has control of strategy production, result in long-lasing, significant improvements in reading comprehension and critical thinking skills. Expert scaffolding is the instructional philosophy underlying many successful forms of instruction, by computers as well as teachers; expert scaffolding involves the gradual transfer of strategic control from experts to novices in such a way that the novices can practice within their gradually expanding range of competence, taking charge of their own learning in the process.

Teaching Students to Think as They Read:
Implications for Curriculum Reform

Higher Order Skills and Reading

Texts are a major source of information available to a literate society. In order to enter that society fully, students must know how to learn from reading. Much of what is called reading in the later grades is actually critical thinking and studying. Students are not only required to decode, i.e., translate the written words into spoken words, they are also required to understand the meaning, critically evaluate the message, remember the content, and even apply the new-found knowledge flexibly and creatively. The premium placed on understanding, remembering, and using information gleaned from texts increases through the high school and college years when texts, to a large extent, take the place of teachers as the primary source of accumulated knowledge. Students who have not honed the necessary critical reading skills suffer a considerable and cumulative disadvantage.

Intelligent Novices

More than ever before schools must equip people to deal with facts that they never encountered in school. In a scientific and technological society based on an increasingly complex and rapidly changing information base, a productive member of society must be able to acquire new facts, critically evaluate them, and adapt to their implications. Reliance on remembered facts and

fallacies from outmoded past schooling will not suffice. Schools, therefore, need to develop intelligent novices (Bransford, Vye, Adams, & Perfetto, in press; Brown, Bransford, Ferrara, & Campione, 1983). Intelligent novices are those who, although they may not possess the background knowledge needed in a new field, know how to go about gaining that knowledge. Intelligent novices have learned how to learn from texts rather than merely to memorize facts.

There is considerable evidence that a sizable minority of school leavers, when they encounter college, the armed forces, or the workplace, lack the skills of the intelligent novice. Questioned about their preferred study strategies, high school students vary in their sophistication. For example, one student claimed that when called upon to study, ". . . I stare real hard at the page, blink my eyes and them open them--and cross my fingers that it will be right here" (pointing at his head). A somewhat better informed peer replied, "It's easy, if she (the teacher) says study, I read it twice. If she says read, it's just once through." A third answered, "I just read the first line in each paragraph--it's usually all there." These are not expert readers. In contrast, intelligent novices possess a wide repertoire of strategies for gaining new knowledge from texts.

Strategies of Critical Reading

Anything other than pleasure reading demands a great deal of effort. Effort alone will not do it, however; one unsuccessful

college student reported reading the text "over and over again, eight or ten times until I fell asleep, and I still didn't pass the test." Effort must be coupled with strategic ingenuity. Expert readers proceed quite differently when they are reading to meet strict criteria of understanding or retention, or attempting to overcome a comprehension failure, than when they are merely reading for pleasure or to obtain a quick impression of the gist. When reading for pleasure they progress rapidly and, seemingly, effortlessly. When they are studying, however, they proceed slowly and laboriously, calling into play a whole variety of learning and self-monitoring activities. Learning from texts demands a split mental focus (Brown, 1980; Locke, 1975). Learners must simultaneously concentrate on the material they are reading and on themselves as learners, monitoring themselves to see if they are actually engaging in mental activities that are resulting in learning.

The strategies involved in reading to learn are quite similar to those mentioned in the accompanying papers on writing (Scardamalia) and math and science (Reif). Reading demands a variety of higher order skills and problem-solving activities because reading is problem-solving. Skilled readers plan their approach to the task at hand, monitor their learning as they read, apply strategies to foster learning, evaluate and if necessary revise their approach to learning from texts. These

general, sometimes called metacognitive, skills promote success across the curriculum (Baker & Brown, 1984a, 1984b).

Concrete versions of general monitoring activities for the domain of reading include: (a) clarifying the purposes of reading, i.e., understanding the task demands, both explicit and implicit; (b) spontaneously making use of relevant background knowledge; (c) allocating attention so that concentration can be focused on the major content at the expense of trivia; (d) critically evaluating content for internal consistency and compatibility with prior knowledge and common sense; (e) monitoring ongoing activities to see if comprehension is occurring, by engaging in such activities as periodic self-review; (f) drawing and testing inferences of many kinds, including interpretations, predictions, and conclusions; and (g) criticizing, refining, and extending the newly acquired knowledge by imagining other uses of the information or counter-examples to the arguments. In short, reading is thinking, and thinking demands effort and skill (Brown, 1980).

Need for Change in the Curriculum

Comprehension Instruction in School

Are students currently acquiring these skills satisfactorily? Unfortunately, the answer must be "no." Although most students learn to decode eventually and there is some evidence that scores in basic reading skills are improving, these encouraging facts are coupled with an alarming decline in

reading comprehension scores. Some have argued that the increased efficiency in decoding has come at the expense of comprehension fluency. Little direct instruction in reading comprehension is found in the content of popular reading curricula or in classroom reading instruction (Durkin, 1985). Within reading groups, the problem of a decoding emphasis at the expense of comprehension training is exacerbated especially for those students whom the teacher regards as poor readers. Good readers are often questioned about the meaning of what they are reading, and asked to criticize material. Poor readers receive extensive practice in decoding and pronunciation. Teachers are more likely to interrupt poor readers immediately when they make an error, thereby disrupting the flow, whereas teachers wait until a good reader has reached the end of a phrase or clause or other "meaning-chunk" before correcting the child. When a child needs help, teachers provide a predominance of decoding cues and practice in word identification skills to the poor readers. For good readers, teachers concentrate on meaning and allow some latitude in decoding fluency and pronunciation (Brophy & Good, 1969; Collins, 1980).

This differential treatment continues well past the stage when the poor reader has reached a level of fluency that would permit the kind of comprehension instruction that more advanced students receive. The initially poor reader who falls even farther behind and attracts a special label is even more likely

to receive extensive therapy focused on decoding rather than comprehension difficulties. Such students are unlikely to develop adequate reading comprehension skills. There could be many reasons for this typical pattern but one that is rarely addressed is the simple explanation of practice. Practice makes possible. If so, perhaps we should not be surprised to find a cumulative deficit in comprehension skills in those who do not receive adequate experience in comprehension-fostering activities at home, in reading group, or in their reading curriculum.

After grade school it is too late, at least in the present system. Formal reading instruction ceases by sixth to eighth grade. High school teachers and students alike define the job of the teacher as conveying content rather than teaching reading ("this should have been done before") or thinking per se ("this cannot be done, at least not at the expense of content"). The only reading instruction available after grade school is clearly marked remedial, and, again, tends to focus largely on decoding skills.

Students' Understanding of the Reading Process

Students whose primary instruction in reading has focused on decoding aloud with correct pronunciation become confused about the goal of reading. Such students believe that reading is being able to say the words correctly. A passage of unrelated words is judged as readable as a coherent passage (Clay, 1973; Johns & Ellis, 1976). Poorer readers seem to be unaware that they must

expend additional cognitive effort to make sense of the words they have decoded. When asked directly, poorer readers rarely report using or believing in the efficacy of active strategies such as giving differential weight to importance at the expense of trivia, skimming for main points, strategic re-reading, questioning, evaluating, or predicting (Baker & Brown, 1984a, 1984b; Paris & Myers, 1981).

Turning to what students do rather than what they say, the same picture emerges (Brown, Armbruster, & Baker, in press). Poor readers compared with good readers show little evidence, when reading, of such learning activities as skimming, looking-back, and other fix-up strategies. They fail to monitor their comprehension deeply enough to permit them to detect violations of internal consistency in texts or even of just plain common sense. They rarely take remedial action even if an error is detected; in short, their comprehension-monitoring is weak to non-existent. They fare little better in comprehension-fostering, failing to question and evaluate the meaning of what they are reading. One could argue that at least in part these problems are the result of lack of experience. It is difficult to perfect cognitive activities that are rarely modeled by teachers or practiced by students. Meaning construction is not a dominant feature of the educational experience of many poor readers in the early grades of school. As a result, expertise in

meaning construction is at best delayed and perhaps permanently impaired.

Successful Instruction in Reading Comprehension

So far we have dealt with the bad news that some, but by no means all, current reading instruction, and especially that aimed at the less gifted student, is not conducive to the learning of higher order comprehension strategies. Whereas basic decoding abilities are acquired by the majority of students, higher order skills of comprehension, interpretation, and application are rarely explicitly taught. Many do not acquire them on their own volition. But they can be taught. Recent research paints an optimistic picture for the efficacy of including direct instruction of reading comprehension, not only in strictly reading and rhetoric classes but widely across the curriculum.

Texts, Tasks, and Strategies

It would be impossible in the space available to summarize the large body of research literature on teaching comprehension. The reader is referred to other sources for a complete review (Bransford et al., in press; Brown et al., 1983; Chipman, Segal, & Glaser, in press; Pearson, Kamil, Barr, & Mosenthal, 1984). Here I will concentrate on successful attempts to help students develop strategies to take charge of their own learning from texts.

There have been many approaches to improving students' reading comprehension, some indirect, such as attempting to

improve their vocabulary or speed of word identification, and some direct, in which attention centers on four important aspects of reading: the text, the task, the learning strategies, and the students' knowledge about texts, tasks, and strategies. Direct attempts are more successful than indirect ones, and some direct attempts are more successful than others. There is no doubt that it helps readers if the texts to be read are well written, form good stories (Omanson, Beck, Voss, & McKeown, 1984; Stein & Trabasso, 1982), or have a logical and coherent structure (Meyer, 1984). It helps readers if the background knowledge necessary to understand the text is provided (Anderson, 1983). It helps readers if difficult vocabulary is removed or explained. But such manipulations of the text, although undoubtedly helpful, do no more than make it possible for the student to read the particular text in question. These manipulations by no means ensure that the student will acquire the necessary skills to read independently a wide variety of texts that are less well written, contain difficult vocabulary, and introduce new content that must be mastered.

Readers need to be able to reorganize poorly written texts, infer the meaning of difficult vocabulary from context, spontaneously bring to bear whatever background knowledge they have that will enable them to understand new content. They require strategies to enable them to perform these activities independently. The best approach to creating independent readers

is to guide them in acquiring strategies for attacking texts on their own.

To illustrate this point, consider the following excerpts from the fictional example of teachers A, B and C (Bereiter, 1984):

> Teacher A is careful to select and sequence reading material so that it builds gradually on students' existing knowledge. Before students read a selection, Teacher A carried out activities designed to activate relevant knowledge that students already have available. This might be done by class discussion of the topic, by having students write a story on the topic, or by having students make predictions about the selection to be read. Unfamiliar concepts and terms appearing in the selection are pre-taught. Students may be alerted to special points to be on the watch for, questions to seek answers for, or difficulties to be prepared for. After the selection to be read, Teacher A guides discussion with questions that lead students to draw inferences from what they have read and to relate what they have read to their other knowledge . . .
>
> Teacher B's approach can best be described by taking all the things that Teacher A does and trying to teach students to do them by themselves. This is not accomplished all at once, of course; and so much of Teacher B's behavior resembles that of Teacher A. But Teacher B's goal is that

eventually it should not be necessary to conduct activities for activating students' prior knowledge, to ask them questions in order to relate new knowledge to old, and so on. Students should be doing that by themselves on their own initiative. Teacher B asks students themselves to recognize what is new and what is old information. Instead of asking questions of the students, Teacher B models the process of asking questions of the text or of oneself and coaches the students in carrying out the modeled process . . . . . Whereas Teacher A tries to minimize students' difficulties in comprehending, Teacher B will sometimes assign reading tasks that present special difficulties in order to provide occasions for teaching problem solving strategies. When difficulties arise they are treated as interesting phenomena for investigation, with the result that the students themselves become students of cognitive processes in reading.

Teacher C typically assigns reading selections with little preparation and then has students answer oral or workbook questions about them. Teacher C then goes through the selection with the class, asking more questions and explaining what it says for the benefit of those who have not understood it. (Bereiter, 1984, ms. pp 7-9)

Classroom observations suggest that the behavior of Teacher

C is fairly representative of reading comprehension activities that actually occur in classrooms (Pearson & Gallagher, 1983). And there is considerable research evidence that the behavior of Teachers A and B represents a marked improvement over that of Teacher C. The difference between Teachers A and B is that, under systems like Teacher A's, the student will understand the particular text well, and there is some chance that the quicker students might learn for themselves how to direct their own reading activities in the future. Teacher B, however, provides explicit instruction in comprehension processes as procedures that should be applied to text comprehension in general. She demonstrates and models the active processes of meaning construction. Students observe these activities and gradually adopt them as part of their own thinking repertoire. The Teacher B approach has resulted in quite dramatic improvement in reading comprehension scores.

To summarize a great deal of literature, instructional procedures that provide practice in composite reading skills out of the actual context of reading, for brief durations, without the students taking charge of the learning strategies, result in brief success at most. In addition, there is little evidence of the student's independent use of those skills across appropriate contexts. As teachers have complained for years, students are reluctant to transfer their knowledge. By contrast, instructional procedures that introduce strategies as they are

needed in the context of actually understanding texts, where the strategies are demonstrated over time, and where the student is fully informed of the purpose of the strategy, produce long-lasting, significant improvements in reading comprehension scores (Brown, Campione, & Day, 1981).

Expert Scaffolding and Reciprocal Teaching

To provide a concrete example, I will describe an instructional program in some detail because: (a) it has proved successful at improving students' reading; (b) it can be handled effectively by average teachers in normal classroom milieux; and (c) it represents one example of a new wave of research on expert scaffolding that is succeeding in emphasizing the importance of the Teacher B approach.

Expert scaffolding refers to situations where an expert (a teacher, a peer, a parent, a mastercraftsman) provides a supporting context in which students may gradually acquire skills. The expert, the teacher, initially takes on the major responsibility for the group's activity. Novices are encouraged to watch and then to participate before they are able to perform unaided, the social context supporting the individual's efforts. The teacher models and explains, relinquishing part of the task to the novices only at the level each one is capable of negotiating at any one point in time. Increasingly, as a novice becomes more competent, the teacher increases her demands, requiring participation at a slightly more challenging level.

One example of expert scaffolding in the classroom is reciprocal teaching (Brown & Palincsar, in press; Palincsar & Brown, 1984). The basic procedure is simple. A teacher and a group of students take turns leading a dialogue concerning a section of text they are jointly attempting to read and understand. The dialogue includes spontaneous discussion and argument, and has four main comprehension-fostering activities: summarizing, questioning, clarifying, and predicting. The adult teacher assigns a segment of the passage to be read and either indicates that it is her turn to be the teacher or assigns a student to teach it. After all have read the segment silently, the teacher (student or adult) for that unit summarizes the content, asks a question that a teacher or a test might reasonably ask, discusses and clarifies any difficulties, and finally makes a prediction about future content. All of these activities are embedded in as natural a dialogue as possible, with the teacher and the students giving feedback to each other.

The instructional design is based on certain central principles. First, the teacher must actively model the desired comprehension activities, thereby making them overt, explicit, and concrete. Comprehension-fostering and monitoring activities are usually difficult to detect in the expert reader, as they are executed covertly. The reciprocal teaching procedure provides a relatively natural forum for the teacher to engage in the strategies overtly, and hence to provide a model of what it is

that expert readers do when they try to understand and remember texts. The modeling also serves to demonstrate to the students concrete ways of monitoring their own learning through methods they can readily understand.

Second, the strategies are always modeled in appropriate contexts, not as isolated, separate skill exercises. The four key strategies of summarizing, questioning, clarifying, and predicting are embedded in the context of the dialogue between students and teacher that takes place during the actual task of reading with a clear goal of deriving meaning from the text. Each separate activity is used in response to a concrete problem of text comprehension. Summarizing is modeled as an activity of self-review. Its purpose is to state to the teacher or the group what has just happened in the text and as a self-test that the content has been understood. If an adequate synopsis cannot be reached, this fact is not regarded as a failure to perform a particular skill but as an important source of information that comprehension is not proceeding as it should, and remedial action such as re-reading or clarifying is needed. Questioning is not an isolated activity, but a continuing goal of the whole enterprise--to what reasonable test can one's new learning be put? Clarifying occurs only if there are confusions, either in the text or in the student's interpretation of the text. Similarly, prediction is attempted if the students or teachers recognize any cues that serve to herald forthcoming material. In

short, all of the activities are undertaken when appropriate in the context of actually reading with the goal of understanding and remembering.

Third, it is an important instructional principle that the students be fully informed of the need for strategic intervention, of where and when to be strategic, and of the fact that using strategies works for them. This line of attack is to ensure that students understand why they must act as requested and learn how critical reading works.

Fourth, the teacher provides feedback that is tailored to the students' existing levels, encouraging them to progress gradually toward full competence. An important feature of the reciprocal teaching procedure is that the students must respond when it is their turn to be the teacher, or when they answer the questions of other teachers. The students respond even if the level of which they are capable is not yet that of an expert. And because the students do respond, the teacher has an opportunity to gauge their competence, competence that is often masked by weaker students' tendencies not to respond until they are sure of themselves.

Fifth, the responsibility for the comprehension activities is transferred to the students as soon as they can take charge of their own learning. Through interactions with the supportive teacher and their more knowledgeable peers, the students are led to perform at an increasingly more mature level; sometimes this

progress is fast, sometimes slow, but, irrespective of the rate, the teacher provides an opportunity for students to respond at a more challenging level. As they master one level of involvement, the teacher increases her demands so that students are gradually called upon to adopt the adult role fully and independently. The teacher then fades into the background and acts as a sympathetic coach leaving the students to take charge of their own learning from texts.

Consider an example of a teacher working on remedial reading with two seventh graders. They are reading a passage about American snakes. One student, Charles, has a great deal of difficulty taking his turn leading the dialogue, primarily because he doesn't know how to formulate an appropriate question. He opens with, "What is found in the Southeastern snake, also the copperhead, rattlesnakes, vipers--they have--I'm not doing this right." The teacher responds to his difficulty and tells him the main idea. "Do you want to ask something about the pit vipers?" When he still fails to ask an adequate question, she prompts, "Ask a good question about the pit vipers that starts with the word why." When he still cannot manage it, she models, "Why do they call the snakes pit vipers?" After two tries, he copies the teacher's question and she provides praise and encouragement. Even imitating a fully formed question is difficult for Charles initially.

Four days later Charles is still having difficulty asking questions. The teacher models one for him, but this time she waits for him to identify the main idea in his question: "How do spinner's mate spend most of his time sitting?" The teacher responds, "You're very close. The question would be, 'How does spinner's mate spend most of his time?' Now you ask it." And he does.

Seven days into the procedure, Charles can make up questions with a little help pinpointing main ideas and by the eleventh day he takes his turn as teacher with two questions, "What is the most interesting of the insect eating plants, and where do the plants live at?" After fifteen days he produces acceptable single questions each time it is his turn to lead the dialogue. Charles: "Why do scientists come to the South Pole to study?" Teacher: "Excellent question--that's what the paragraph is all about!"

In contrast to Charles, the other student in the group, Sara, has a clear idea of what kinds of questions occur in schools--"fill in the blanks." The teacher, preoccupied with Charles, tolerates such questions until the second day and then attempts to take Sara beyond this level. Sara: "Snakes' backbones can have as many as 300 vertebrates - almost blank,blank,blank times as many as humans?" Teacher: "Not a bad beginning, but that's a question about a detail. Try to avoid 'fill in the blanks' questions. See if next time you can find a

main idea question and begin your question with a question word - how, why, when . . ."

On the third day, Sara comes up with a main idea question, but this time she selects a line in the text, "several varieties of snakes live all their lives in the sea," and turns it into a question, "Can snakes live their whole lives in seas?" The teacher again increases her demand, "Fine, but see if you can ask a question using your own words." For the remainder of the sessions, Sara composes questions in her own words becoming more and more like the model teacher in her turn.

This individual attention to students' difficulties is possible in larger groups. For example, consider the dialogues in Tables 1 and 2. These take place between a regular seventh grade classroom teacher and her remedial reading group. The dialogues are from early (Day 3) and late (Day 13) sessions for the same group of five students.

Both the early and late dialogues attest to the fact that the students and teacher were able to engage in a smooth flowing discussion. On Day 3, however, the teacher is very much the pivotal participant. As can be seen in Table 1, one session of the silent reading is followed by one extensive dialogue, where the students interact with one another only once (statements 1-3); the remainder of the dialogue runs are S-T, S-T, student followed by teacher. Note also that the entire interaction focuses on one segment of text and on one disputed point--the use

of snakes' tongues. Interestingly, another group had problems with this segment, one student reading, "No snake's tongue is completely harmless," instead of the correct, "No - snakes' tongues are completely harmless," thus generating an interesting confusion and occasion for clarification.

The same group is seen again, ten intervention days later, in the dialogue shown in Table 2. Here four reading-dialogue sets are included in 29 statements, rather than only one as in Table 1. Now the majority of the dialogue "runs" are student-controlled, with the teacher interspersing praise and encouragement (4,10,12) and some management (4,14,21). The teacher only intercedes with advice and modeling when a student misses the point and the other students do not catch it (statements 18,26,28). The teacher has moved from the pivotal role of responding individually to each child to a coach who sits in the background, offers encouragement, and occasionally pushes for a better interpretation of the text. The expert provides just the degree of scaffolding necessary for the dialogue to remain on track, leaving the students to take as much responsibility as they can.

Using reciprocal teaching as the daily reading instruction for periods of between three and six weeks has resulted in a wide range of improvements in the comprehension scores of junior high school poor readers. Not only did they improve their ability to summarize, question, clarify, and predict in the dialogues, they

also progressed from passive observers to active teachers, able to lead the dialogues independently, and, in some cases, eventually to take on the role of peer tutors. Outside the group, there were large and reliable improvements on daily comprehension tests that the students took independently, on classroom measures of comprehension, and on transfer tests such as writing summaries, predicting test questions, and detecting text anomalies. For the majority of students there were significant improvements on standardized tests of comprehension.

Equally important, the procedure was instructionally feasible. Regular classroom teachers were effective with the procedure, and they were enthusiastic about incorporating it into their routine teaching repertoire. It is important to note that average classroom teachers can introduce the procedure into reading groups that consist of ten or more students, and the procedure can be adapted to include the whole classroom. For example, teachers have used a modified version of reciprocal teaching to direct portions of their science classes. The number of students in these classes made the oral turn-taking of reciprocal teaching unwieldy. In its place, they substituted a procedure whereby the students and teacher read the text silently and after each segment privately wrote down a summary, question, clarification, and prediction. After several segments had been covered, the teacher asked students to volunteer their responses and wrote several candidate summaries (questions, clarifications,

and predictions) on the board. Then the students as a group debated the merits of each until they reached a degree of consensus on the most appropriate version. Over the term the students showed marked improvement on their written versions of the four activities and in their classroom participation. In addition, the students improved significantly on independent tests of comprehension.

The reciprocal teaching method is applicable to a wide age and ability range. Although the original program of research was conducted with below-average junior high school students, it has also been used successfully with gifted third graders and learning disabled college students. Expert modeling followed by student practice on the explicit rules underlying critical reading has resulted in successful interventions with first graders (Au & Kawakami, in press), normal high school students (Bird, 1980), and junior college students with and without diagnosed reading problems (Day, 1980). Situations where pairs of college students take turns talking-aloud about their problem solving processes, with one member of the pair acting as problem solver and the other as critic have improved reading (Frase & Schwartz, 1975), studying (Bloom & Broder, 1950), and problem solving (Whimbey & Lockhead, 1982).

It is also important to note that the method is not restricted to reading. Expert scaffolding is the instructional philosophy that lies behind successful instructions by: (a)

computers in such areas as physics (Heller & Hungate, 1984), electronics trouble-shooting (Brown, Burton, & deKleer, 1982), and early mathematics (Feurzig & White, 1984); (b) teachers in story telling (McNamee, 1981), listening comprehension (Brown & Palincsar, in press), and writing (Applebee & Langer, 1983; Scardamalia, 1984); (c) peers in study strategies and problem solving (Bloom & Broder, 1950; Frase & Schwartz, 1975); and parents in picture book reading (Ninio & Bruner, 1978), counting algorithms (Saxe, Gearhart, & Guberman, 1984) and problem solving (Wertsch, 1979). The idea of gradual transfer of strategic control from expert to novice is a crucial feature in the informal teaching and learning that occurs in natural tutoring situations, between parent and child, mastercraftsman and apprentice, or teacher and student.

Implications for Curriculum Reform

Thinking Skills Across the Curriculum

A consideration of successful instructional programs for teaching higher order skills of reading comprehension strongly suggests that the skills can be taught effectively across the curriculum and that this would lead to enhanced critical thinking and reading skills, as well as improved performance in the content areas. What is being advocated is a two-level approach to the teaching of most subject areas. Instruction should simultaneously introduce the content to be mastered and the thinking processes that will ensure that mastery. The student

should be charged with acquiring the ways of thinking and problem solving within the domain as well as retention of the content knowledge. Within each subject area, students should observe and practice the domain-appropriate strategies, receive direct experience in the orchestration, overseeing, and monitoring of those strategies, and be constantly reminded of the significance of the activities and their range of utility.

Changes in Teaching Practices

Teachers who have witnessed the success of expert scaffolding methods are enthusiastic about the process. The major impediments to incorporating such a method into their repertoire are: (a) self-consciousness about exposing their own weaknesses; (b) fear of exposing weaker students' problems; and (c) loss of control in the classroom. Teachers and students alike are afraid of making mistakes, and this is natural. But errorless performance has its drawbacks. Errorless learning programs are ineffective in promoting persistence in the face of obstacles. Students become dependent on easy success in order to feel smart and are more likely to interpret setbacks as failures (Dweck & Bempechat, 1984).

Hutchinson (in press) describes the learning problems of Black inner-city junior college students who had not learned to question their hypotheses or confront their errors. The students were asked to work in pairs, talking out loud about their hypotheses and acting as critics to each other. The students had

great difficulty adopting the procedure, not because they couldn't think aloud, but because they were unwilling or unable to deal with problem difficulty or failure. They were intolerant of criticism from either themselves or others. Wertime (1979) has argued that we need to help students increase their "courage-spans" for academic problem solving, courage spans that would enable them to accept failures as temporary false starts and blind alleys that can be overcome, to regard errors as information to be evaluated and used. Students need to know that things are ambiguous. They must evaluate and judge information, seek contrary evidence to their own position; in short, become constructive critics, and most important, become constructive self-critics.

Teachers need these experiences too. It might be helpful to promote the concept of a classroom as a social group for figuring out the best answer, or best approach to a problem, where some have expertise and some do not, where the teacher is a coach rather than an infallible information source. To encourage this, reciprocal teaching could take place on many levels, first between teachers learning the procedure, then between teachers and students, and finally between student peers.

Changes in Textbooks and Other Instructional Materials

Textbooks can be written in such a way that they encourage students to practice thinking skills as well as gain content. software where part of the expert scaffolding can be placed in

the hands of the computer. Such programs already exist in preliminary stages, for example, for physics instruction (Heller & Hungate, 1984) and elementary arithmetic (Feurzig & White, 1984).

Computers that can present miniature worlds in which students can both observe a computer coach and themselves take part in generating ideas, planning, allocating resources, troubleshooting, monitoring, and revising strategies already exist and can serve as the prototype for the development of educational softwear across a wide spectrum of content areas (Sleeman & Brown, 1982). Intelligent computer coaches could give students simple problems to solve while recording both the hypotheses they formulate, as well as their answers. Such systems could score the students' responses and give feedback on their performance and suggestions as to what strategies might be more effective. The problem set for each student could be individually calibrated to the student's initial competence and learning rate. The development of such programs across the curriculum is an important step for the future of education. The use of a variety of innovative information technologies could "help to overcome some of the bottlenecks caused by limitations of teacher time and expertise" (Lesgold & Reif, 1983).

Changes in Student Assessment and Testing

This is a major problem. If teachers and students alike are held responsible to the tests, and only the tests, and if the

tests probe rote retention of content facts alone, then it will be difficult to engineer significant changes in educational practice. But tests drive teaching and learning in nontrivial ways. Consider the reciprocal teaching program. One major measure of the program's success is the student's independent performance on comprehension tests. Endemic in educational testing, these tests consist of passages to be read, followed by a series of questions to be answered on the content. Such questions can and usually do probe fact retention and rather direct inferences based on those facts. Merely changing from multiple choice to short answer formats changes reading style. So does asking for interpretation rather than fact retention. For example, suppose that after reading a passage about the history of masks that included the information that cavemen used masks of animals when they hunted because they believed that the animals would mistake them for one of their kind, grade school children are given the following problem embedded in a series of such problems: Indians in the prairies covered themselves in deer hide when they went on hunting parties--why might this be so? Repeated practice noting the analogy between a text fact (masks of animals make the animals think the cavemen are fellows) and a problem solution (deer confuse deer-skin covered Indians for deer) leads to quite different methods of reading than does practice on questions that examine only verbatim retention. Standardized tests can be designed so that they map better with

the two-level approach of teaching both content and critical reading across the curriculum. In addition, some alternatives to existing testing--computer adaptive testing of thinking skills, student portfolios, essays, or projects--should be considered.

Changes in School Organization and Social Climate

Changes in learning climate follow naturally from the above discussion. If experts and novices are jointly involved in reaching the most satisfactory interpretation of available information, the experts and novices must spend more time discussing, fact finding, and evaluating. Teachers cannot lecture, and students learn, as the only source of information transfer. Introducing the concept of critical reading and teaching across the curriculum would itself lead to changes in learning climates within schools.

Changes in Public Perception

Success breeds success, because success breeds feelings of self-worth and personal efficacy, i.e., the confidence to teach and to learn strategies in the belief that they will work. If these programs are successful, public perceptions will change for the better. Some concrete suggestions are: (a) publicize the results of successful programs, the public hears mainly about school failures; (b) set up model systems of instruction, in classrooms and on computers, and make them available for public inspection; (c) involve experts from various domains in the teaching process; (d) encourage expert-scaffolding procedures in

homework assignments; (e) encourage parents, teachers, and students to work cooperatively on computer tutoring systems; and (f) make traditional and computer literacy for all a community project.

There are exciting new trends in educational research and a considerable convergence of opinion on how to improve education across the curriculum. The time is ripe for capitalizing on these trends. Teaching higher order skills of critical thinking and reading would improve education in many academic domains and would prepare students to face the rapidly changing conditions that adult life in a complex technological society will demand.

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Table 1 Reciprocal Dialogue from an Early Session; Study 2, Group 3, Day 3.

Text:

> CAN SNAKES STING WITH THEIR TONGUES?
> No--snakes' tongues are completely harmless. They're used for feeling things and for sharpening the snakes' sense of smell. Although snakes can smell in the usual way, the tongue flickering in the air picks up tiny particles of matter. These particles are deposited in two tiny cavities at the base of the nostrils to increase the snakes's ability to smell.

1. A: Do snakes' tongues sting?
2. K: Sometimes.
3. A: Correct.
   This paragraph is about do snakes sting with their tongue, and different ways that the tongue is for and the senses of smell.
4. *T: Are there any questions?
5. C: Snakes' tongues don't sting.
6. *T: Beautiful! I thought, boy, I must have been doing some fast reading there because I missed that point. A_____, could you ask your question again?
7. A: Do snakes' tongues really sting?
8. *T: Now, A_____, since you have asked the question, can you find in that paragraph where the question in answered?
9. A: No, snakes' tongues are completely harmless.
10. *T: So we'll try it again. Can you generate another question that you think a teacher might ask?
11. A: What are the tongues used for?
12. *T: Good!
13. L: The sense of smell.
14. *T: Is that correct? A_____, do you disagree? Yes.
15. A: That answer was right, but there are other things that the tongue can do.
16. L: But she only said tell one, she didn't say tell all of them.
17. *T: O.K.
18. B: It is used to pick up tiny particles.
19. *T: O.K. I think that this is an important point. You have the basic concept which is correct, O.K., but what the question really is saying is, is it used for smell? O.K.?
20. B: They are used for feeling things for sharpening snakes' sense of smell.
21. *T: O.K. They are used for sharpening the snakes' sense of smell. Are they used for smelling? That's the point we aren't clear on.
22. L: In my answer I said it is for the sense of smell.
23. *T: This is fine; this is what the technique is all about. What it means is not that you are right or wrong or good or bad. What it says is that we have just read something and have had a disagreement about what it says. We need to work it out.
24. A: My prediction is that they will now talk about the different things about snakes. Where they live, and what they eat and stuff like that.
25. *T: O.K. Good. What do you think they eat?
26. A: Animals.
27. A: Deserts.
28. C: I challenge. Snakes, all of them, don't live in the desert. They live in the woods and in swamp areas.

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* Indicates turns taken by adult teacher.

Table 2 Reciprocal Dialogue from a Later Session: Study 2, Group 3, Day 13

Text: In the United States salt is produced by three basic methods: solar (sun) evaporation, mining, and artificial heat evaporation. For salt to be extracted by solar evaporation, the weather must be hot and dry. Thus, solar salt is harvested in the tropic-like areas along our southern ocean coasts and at Great Salt Lake.

1. C: Name three different basic methods how salt is produced.
2. A: Evaporation, mining, evaporation ... artificial heat evaporation.
3. C: Correct, very good. My summary on this paragraph is about ways that salt is being produced.
4. *T: Very good. Could you select the next teacher?
(Student selects another student)

Text: The second oldest form of salt production is mining. Unlike early methods that made the work extremely dangerous and difficult, today's methods use special machinery, and salt mining is easier and safer. The old expression "back to the salt mine" no longer applies.

5. L: Name two words that often describe mining salt in the old days.
6. K: Back to the salt mines?
7. L: No. Angela?
8. A: Dangerous and difficult.
9. L: Correct. This paragraph is all about comparing the old mining of salt and today's mining of salt.
10. *T: Beautiful!
11. L: I have a prediction to make.
12. *T: Good.
13. L: I think it might tell when salt was first discovered, well, it might tell what salt is made of and how it's made.
14. *T: O.K. Can we have another teacher?

Text: Table salt is made by the third method -- artificial evaporation. Pumping water into an underground salt bed dissolves the salt to make a brine that is brought to the surface. After purification at high temperatures, the salt is ready for our tables.

15. K: After purification at high temperatures the salt is ready for what?
16. C: Our tables.
17. K: That's correct. To summarize: After its purification, the salt is put on our tables.
18. *T: That was a fine job, Ken, and I appreciate all that work, but I think there might be something else to add to our summary. There is more important information that I think we need to include. This paragraph is mostly about what?
19. A: The third method of artificial evaporation.
20. B: It mainly tells about pumping water from an underground salt bed that dissolves the salt to make a brine that is brought to the surface.
21. *T: Angela hit it right on the money. This paragraph is mostly about the method of artificial evaporation and then everything else in the paragraph is telling us about that process. O.K. Next teacher.

Table 2 (cont' d)

Text:

> For thousands of years people have known salt--tasting it, using it for their lives' needs. Sometimes it has been treasured as gold; other times it has been superstitiously tossed over the shoulder to ward off bad luck. Somehow people and salt have always been together, but never is the tie more complete than when the best people are called "the salt of the earth."

22. C: My question is, what are the best people called?
23. L: The salt of the earth.
24. C: Why?
25. L: Because salt and the people have been together so long.
26. *T: Chris, do you have something to add to that? O.K. It really isn't because they have been together so long; it has to do with something else. Brian?
27. B: (reading) "People and salt have always been together but never has the tie been so complete."
28. *T: Allright, but when we use the expression, "That person is the salt of the earth," we know that means that person is a good person. How do we know that?
29. B: Because we treasure salt, like gold.

* Indicates turns taken by adult teacher.